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Summary of Proton Test on the Actel CKJ911

Prototype at Indiana University

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Test Facility

The Actel CKJ911 prototype FPGA was tested at the Indiana University Cyclotron Facility (IUCF). The proton energy was 193 MeV and the flux was set at approximately 1×10^9 p/cm²/sec. The total fluence for each device was determined by the total dose response of the device and its affect on the current draw; details for each device including bias are given in the

chart below. The device was irradiated normal to the beam.

Device Under Test

The devices were in a PQFP208 package and were active during irradiation. Upsets and currents were monitored in real-time with the device being clocked at 1 MHz. The stimulation pattern was a 500 kHz square wave. The test pattern used contains 400 flip-flops. The CKJ911 architecture only has hard-wired flip-flops with the available software; there are no I/O module flip-flops.

Sample devices were taken from a prototype lot, with I_{DDSB} currents higher than would be expected from a full-scale production lot. The "p-fuse" was not programmed on these devices and the TCK pin (an input to the IEEE 1149.1 JTAG TAP controller) was not active.

Test Results

The following table summarizes the device, bias conditions, and irradiations.

S/N	Lot	Bias (Volts)	Total Dose kRads (Si)	Upsets	Fluence (p/cm ²)
CKJ1	Prototype	4.5/3.0	116.9	2	1.9×10^{12}
CKJ2	Prototype	5.0/3.3	100.1	0	1.6×10^{12}

Two devices were irradiated, one with biases of 4.5V and 3.0V and the other with biases of 5.0V and 3.3V. An estimate of an upper bound for the cross-sections can be computed as 2.6×10^{-15} cm²/flip-flop at the worst-case voltage and, assuming a single upset, as 1.6×10^{-15} cm²/flip-flop at nominal supply voltages.

There was no clock upset detected in any of the devices and no upsets were detected in the JTAG TAP controller.

The device's total dose performance was good, despite the high initial device bias currents. The dose rate was high at 252 kRads (Si) / hour for S/N CKJ1 and 316 kRads (Si) / hour for S/N CKJ2. Details are shown in the strip charts below for the 3.3V supply currents.

Only moderate ($< 250 \mu A$) changes in the 5V bias currents were observed.

